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OCCURRENCE, BEHAVIOR, AND COST OF FIRES IN RELATION TO FOREST FIRE DANGER

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Measuring the variables of forest fire danger, integrating them into specific danger classes, and using these numerical ratings as guides in dispatching is a relatively new fire control procedure in the East and field men have had little chance to determine what differences in occurence and behavior of fires usually accompany changes in fire danger. This is particularly true in the southern Appalachian Mountain forests where the Appalachian fire danger meter[1] has been in use only a few months.

Some knowledge of future expectancies can be obtained from analyses of fire reports and comparisons of past occurrences with fire danger as computed from available weather records. Data derived from this type of investigation may provide usable indices or rules of thumb for field fire control officers.

In a recent analysis of all 1932 - 1937 Pisgah National Forest (North Carolina) fire reports, occurrence, behavior, and cost data were correlated with class of fire danger, determined from Asheville, N. C., weather records. Two weaknesses in the data decrease the validity of results: (1) certain data from the fire reports were estimates, and (2) danger ratings, based on Asheville weather records, are not applicable to the time and place of every fire. However, in most cases, averages of the 440 to 467 fires establish very definite trends. While absolute values may be in error, the relation of the occurrence, behavior, and cost to fire danger class is reasonably accurate. The results of the analysis, presented in table 1, are averages for fires of all sizes burning in all fuel types common to the Pisgah Forest.

1/ The Appalachian fire danger meter, described in Technical Note No. 26, January 27, 1938, integrates amount of precipitation and time elapsed since its occurrence, relative humidity, wind velocity, season of the year, and visibility distance, expressing the result on a numerical scale of fire danger classes. The usual fire control organization required for each class of danger is given, from class 1 which represents no danger, to class 5 which represents the very greatest.

Probability of Occurrence.

The probability of fires starting on days of each danger class was determined by comparing the proportion of the total number of fires on days of each class with the proportion of the total number of days in each class. For example, class 1 days occurred eleven percent of the time but less than two percent of all fires started on class 1 days. Class 5 days occurred one percent of the time but more than nine percent of the fires burned on these few days.

The occurrence probabilities for fires of all causes, read from table 1, can be interpreted as follows: In the past, there has been 56 times the chance of a fire being started on a class 5 day as on a class 1 day, 23 times the chance on a class 4 as on a class 1 day, etc.

Because of the activity of debris burners and incendiarists on days of high danger, the occurrence probabilities, not including fires caused by these agents, are more indicative of the relative likelihood of fires starting on class 1 to class 5 days. Table 1 shows that the chances of a firebrand starting a fire on a class 5 day are 28 times greater than on a class 1 day.

From the table (fourth column) it is seen that about 60 out of every 100 class 5 days have at least one fire, but a fire occurs on only two or three out of every 100 class 1 days.

Rate of Spread.

As would be expected, the rate of perimeter increase per hour (origin to arrival) is much greater on days of high danger. In table 1, spreads are listed for all fires and for those attacked within 12 hours. The few lightning fires with long discovery times, included in the first category, bring down the average spread, especially in low danger classes.

Rate of spread during corral is greater on class 5 than on class 1 days. This is evidently the case because fires are larger at arrival on class 5 days and therefore have more perimeter to contribute to spread during corral. Strangely enough, the reports show that during corral a chain of a fire's perimeter on a class 5 day spreads no more in an hour than a chain of perimeter on a class 1 day. Two explanations are offered for this paradox. On class 5 days, probably a larger percentage of fires have topped ridges or reached roads and other barriers due to fast initial runs. Corral spread is therefore confined to the sides and rear of many fires. On days of lesser danger, most fires at arrival probably have not yet reached topographic or other barriers. Also, due to the activities of crews, a point that will be discussed later, the free-burning perimeters of fires on days of high danger is reduced more rapidly than on days when lesser danger prevails.

Rate of Held Line Construction.

The data show a definite increase in the output of held line per man-hour as fire danger increases. This fact contradicts the opinion that lost efficiency on fast spreading fires reduces the rate of held

line construction. Possibly men work harder and produce more under the pressure of critical situations. A more logical explanation, however, is that the tendency to overman fires with C.C.C. crews is most apparent on less hazardous days. It is common practice, when manpower is abundant, to send a whole crew where a few men could actually handle the fire. In other words, it is easy to overman a fire on a class 1 day. The result is less output per man under these conditions.

Area.

The final size of the average fire mounts rapidly with class 4 and class 5 danger, in spite of much faster discovery, arrival, and corral times for fires on these high danger days.

Costs.

As would be expected from the foregoing data on size and rate of spread, the average cost per fire increases in proportion to fire danger. Costs per chain of held line to corral, however, show no relation to class of danger. Evidently the costs of lost line and extra overhead associated with fires on bad days are offset by the increase in production per man hour for high danger conditions.

Conclusions.

These data emphasize the potentialities that confront a fire control organization in the southern Appalachians on days of each fire danger class. The rapid increase in the probability of a fire occurring as danger mounts, indicates need for prevention contact work particularly on class 4 and class 5 days. The data show that an organization stands to lose much more in dollars and acres as fire danger increases.

An accurate knowledge of current danger and an understanding of the occurrence and behavior to be expected for all conditions is therefore essential to sound fire control practice.

Table 1. Relation between class of fire danger and occurrence, rate of spread, area, and cost of fires[1]

Class of Fire Danger	Occurrence probability: Fires of all causes	Occurrence probability: Exclusive of debris burner and incendiary fires	Percent of total days on which fires occur	Rate of spread, perimeter per hour (origin to arrival): All fires	Rate of spread, perimeter per hour (origin to arrival): Fires attacked within 12 hrs.	Average perimeter increase per hour during corral	Average rate of held line construction to corral	Average final area per fire	Average sup-pression cost per fire
			Percent	Chains	Chains	Chains	Chs./man hr.	Acres	
1	1.0	1.0	2.5	1.3	4.6	3.2	1.82	3.9	$ 22.00
2	1.8	1.4	5.5	3.2	7.1	6.0	1.96	4.2	38.00
3	8.0	4.0	18.0	8.2	10.6	8.0	2.11	7.4	55.00
4	22.8	9.5	39.0	12.8	17.1	9.1	2.25	25.0	72.00
5	56.2	28.6	59.5	16.2	20.0	9.9	2.40	45.8	88.00

1/ Based on 440 to 467 fires on the Pisgah National Forest, 1932 - 1937, inclusive. Class of fire danger from Asheville, N. C., weather records, using Appalachian fire danger meter.